

The rotor is driven by high-pressure air ejected through tip nozzles, which eliminates the need for the usual transmission. The flight vehicle will use turbofan engines to supply high-pressure air to the rotor. In the wind tunnel test, the Ames high-pressure air supply system was used to simulate the engine exhaust.

Previous tests at Ames evaluated performance at high speeds (rotor stopped) and in hover. In the latest test, full conversion was achieved at 150 knots, both with and without hub springs. The test included

measurements of rotor loads, stability, control power, and forward flight performance.

Test preparations included addition of a 0.5-megawatt heater to the high-pressure air supply, upgraded air-supply valves, and improved safety protection for the control room. Boeing provided the data-acquisition system.

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Advanced Methods for Testing Rotor Performance

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A principal advantage of rotorcraft is their ability to hover, and the efficiency with which they can hover is fundamental to helicopter productivity. It is surprising, therefore, that the ability to predict hover efficiency (and thus design optimum rotors) is limited. This is because the rotor flow field is so sensitive to the rotor wake that there are large analytical errors. This same wake sensitivity also causes large experimental errors. (If a perfect prediction capability

existed, there would be no way to know it, because of experimental error.) Therefore, the attainment of greater rotor analysis capability is a twofold problem of improving both computational and experimental accuracy. This effort is directed at the experimental part of the problem.

Measuring hover performance experimentally is complicated, principally because hover flows are plagued by a range of errors that are related to the

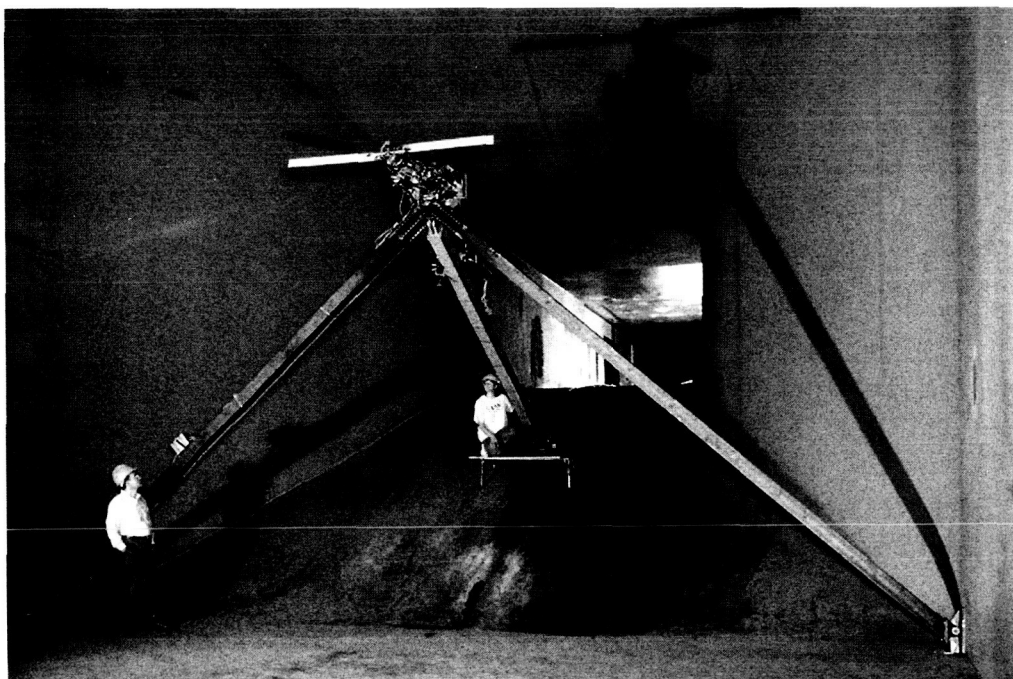


Fig. 1. Setup used to test model rotors in climb.

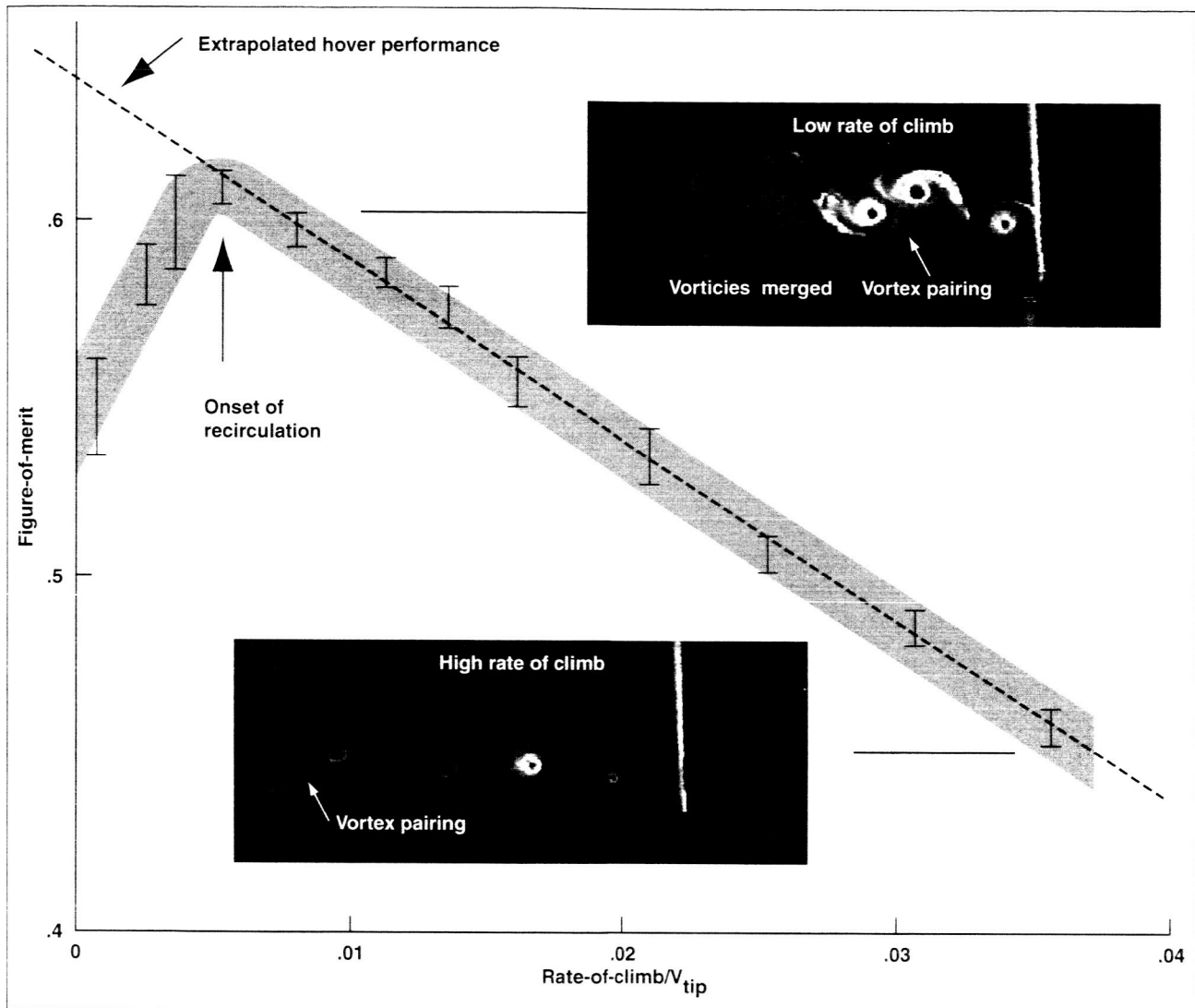


Fig. 2. Plot of the effect of climb on rotor efficiency. The data are very steady and are a linear function of climb rate until the onset of flow recirculation at very low climb. The linear trend can be extrapolated to find the hover performance.

wake sensitivity and to the effects of the ambient environment (including wind effects in outdoor testing and recirculation effects in test chambers). Recently, a new approach to model-rotor performance measurement has been tested. In this approach, the model is mounted horizontally in a wind tunnel settling chamber, thereby simulating climb. The resulting flows are found to suppress chamber recirculation to low-rate-of-climb levels that approach hover very closely. It appears that reliable hover performance can be obtained by a straightforward extrapolation of these climb results. The first

figure is a photograph of the test setup in the settling chamber of the Ames 7- by 10-Foot Wind Tunnel. The reliable data trends obtained with this test arrangement are demonstrated in the second figure. The insets in this second figure show the high quality flow visualizations of the rotor wake obtained with this setup—this is a result of the very steady flow that this test approach produces.

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